California Environmental Protection Agency

Air Resources Board

Proposed Amendments to the California Alternative Fuels for Motor Vehicle Regulations

Proposed Amendments to the Compressed Natural Gas and Liquefied Petroleum Gas Specifications in the Alternative Fuels for Motor Vehicle Regulations

STAFF REPORT: INITIAL STATEMENT OF REASONS

State of California
California Environmental Protection Agency
AIR RESOURCES BOARD
Stationary Source Division

STAFF REPORT: INITIAL STATEMENT OF REASONS PROPOSED AMENDMENTS TO THE ALTERNATIVE FUELS FOR MOTOR VEHICLE REGULATIONS

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California Alternative Fuel Regulations

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I. Executive Summary

A. Introduction

This report is the Initial Statement of Reasons for the proposed amendments to sections 2292.5 – 2292.6, Title 13, California Code of Regulations. Section 2292.5 contains specifications for compressed natural gas (CNG) sold for motor vehicle use, while section 2292.6 contains the motor vehicle liquefied petroleum gas (LPG) specifications. Section 2291 prohibits the sale or supply of motor vehicle CNG and LPG in California that does not meet the specifications contained in sections 2292.5 and 2292.6. This summary first discusses the proposed amendments for CNG and the second part discusses the proposed amendments for LPG.

A previous report regarding the CNG and LPG specifications was published in 1991[1]. Additional reports regarding LPG were published in 1994[2], 1997[3], and 1998[4].

B. Compressed Natural Gas

1. Summary of Proposed CNG Amendments

a. Why is staff proposing amendments to the alternative fuels regulations for CNG?

Staff is proposing amendments to the alternative fuels regulations for CNG to increase compliance flexibility and the availability of complying motor vehicle CNG in California.

The current CNG fuel specifications consist of a set of prescriptive limits that restrict flexibility in complying with the CNG fuel specifications. Due to these narrow limits, much of the CNG produced in the Southern San Joaquin Valley and the South Central Coast does not comply with the CNG fuel specifications. The reason for this is because natural gas produced in these regions is produced in association with oil production where oil constituents can contaminate the natural gas, thus making the natural gas out of specification. In other parts of the State, natural gas is either imported or produced from gas wells (not associated with oil) where the natural gas is relatively clean and meets the CNG fuel specifications.

b. How do the proposed amendments provide more compliance flexibility?

In the past, engine manufacturers and the natural gas industry have used the specific composition of CNG to evaluate CNG fuel quality and its effect on engine performance and emissions. However more recently, engine manufacturers have developed indices such as methane number and Wobbe Index to assess CNG fuel quality. These indices do not specifically limit the compositional make-up of CNG but establishes performance thresholds for which engines can properly operate. Therefore, proposing a CNG fuel specification by one of these indices (e.g. methane number) would provide additional compliance flexibility and increase the availability of compliant CNG.

Engine manufacturers have also developed new technology engines that can operate on wider variations in CNG fuel quality. These new technology engines are equipped with advanced feedback control systems that compensate for varying fuel quality; thus allowing the engine to

operate on a wide range of CNG composition. In comparison to the existing CNG fuel specifications, these engines can expand the CNG compositional range that would be acceptable for proper engine operation. Therefore, proposing an alternative CNG specification in recognition of new advance technology engines would also allow additional compliance flexibility and increase the availability of compliant CNG.

c. What is Methane Number and why is it necessary?

Methane number (MN) for CNG is similar to the octane number used in gasoline. Like octane number, MN provides an indication of the knock tendency of the fuel. MN can be calculated from the fuel composition as demonstrated in Appendix D. The primary benefit from using MN is the flexibility it provides in allowing the CNG composition to vary. A producer can improve gas quality by choosing which fuel components to remove. The heavier or higher carbon chain components are easier to remove and have more of an adverse influence on the MN than the lighter components. Thereby a reduction of the heavier components will have a larger positive impact on the MN (resulting in an improvement in gas quality) than the lighter components.

d. What amendments to the alternative fuels regulations are being proposed?

Staff is proposing that a statewide CNG methane number (MN) specification of at least 80 be added as an alternative to the existing CNG specifications. This provision would allow the CNG producers and providers more flexibility to comply with the regulations while ensuring that engine performance and emissions will not be affected.

In addition, staff is proposing an alternative CNG specification of MN 73 for CNG fueling facilities in the Southern San Joaquin Valley (SSJV) and the South Central Coast (SCC) that meet the following criteria:

1) The natural gas service provider does not provide natural gas that meets an MN of 80 at the service connection;

2) The vehicles fueled at the facility are recommended by the engine manufacturer as being able of operating on CNG with a MN of 73; and

3) The fueling station has controls in place to prevent misfueling.

2. Effects of the Proposed CNG Amendments

a. Who will be affected by the amendments?

Producers, gas companies, fuel station owners, fleet owners, and vehicle owners will all benefit from the proposed CNG amendments. The proposed amendments will provide flexibility and increase the supply of motor vehicle CNG.

b. How will the proposed amendments affect fuel quality?

The existing CNG specifications equate to a MN of about 81 and are almost equivalent to the proposed MN 80 specification. The MN 80 specification represents a minimum fuel quality

specification recommended by engine manufacturers that is protective of existing and future technology engines.

The proposed MN 73 specification is significantly different than the existing CNG fuel specifications and represents a broader range of fuel quality. Engine manufacturers recognize that advanced and future technology engines can and would be able to properly operate on a MN 73 specification without significantly affecting emissions and with no impact on engine performance and durability. The proposed MN 73 specification will be limited to advanced and future technology engines in the SSJV and SCC. The MN 73 specification is not recommended for the SCAQMD as the extensive CNG fleet has too many of the older technology vehicles to allow for the dual approach. The additional flexibility is not needed in the remainder of the State as the CNG is from imported natural gas, which is very high quality.

c. How will the proposed amendments affect the availability of fuel?

The proposed amendments for CNG will provide more flexibility for the natural gas suppliers including producers to comply with the motor vehicle CNG fuel specifications. By providing additional compliance options, the proposed amendments allow gas suppliers to tailor modifications to their facilities, which will enable easier compliance with the specifications; thereby increasing the availability of motor vehicle grade CNG fuel.

d. How will these proposed amendments affect engine performance?

Engine manufacturers recommend that open loop and first generation closed loop technology CNG engines utilize fuel that meets a minimum MN of 80. This specification allows these engines to properly operate and maintain performance. Advanced technology closed loop engines are equipped with improved feedback controls which allow these engines to operate on a broader range of fuel quality. Engine manufacturers believe that advanced technology engines can properly operate on CNG with a MN of 73.

3. Regulatory Development Process and Evaluation of Alternatives

a. What process did the ARB staff use to develop the proposed amendments?

The staff developed the proposed CNG amendments with the participation of stakeholders that included the Southern California Gas Company (SoCalGas), natural gas producers, vehicle fleet owners, CNG fueling station owners, and engine manufacturers. The Engine Manufacturers Association (EMA), Western States Petroleum Association (WSPA), California Independent Producers Association (CIPA) and the Independent Oil Producers Association (IOPA) were instrumental in coordinating the participation of their respective members.

Several joint industry meetings were conducted in addition to individual meetings and teleconferences with the SoCalGas, the producer associations and the engine manufacturers. The staff worked with SoCalGas to discuss existing and potential compliance options to meet the current CNG specifications. Staff also held conference calls with individual engine manufacturers to discuss engine technologies and fueling requirements for the vehicles. Staff met and discussed with the producer associations and individual natural gas producers to evaluate the processing capabilities of production sites.

Staff plans to conduct a public workshop after the release of the staff report to discuss the proposed amendments to the CNG motor vehicle fuel specifications.

b. What other alternatives were evaluated?

The CNG amendments are being proposed to add more flexibility and increase the supply of these fuels for motor vehicles. The alternative would be to not amend the existing regulations.

4. Compliance with the Proposed CNG Amendments

a. How is the industry complying with the current CNG standards?

Less than one percent of the natural gas used in the State is compressed and used as CNG motor vehicle fuel. Most of the pipeline gas used to produce CNG in the State complies with the motor vehicle fuel specifications. However, about ten percent of the pipeline gas used to produce CNG does not comply with these fuel specifications. This non-complying fuel is primarily found in areas that have natural gas production associated with oil production. These areas are in the SSJV, SCC, and parts of the Los Angeles Basin.

In the SSJV and the SCC, SoCalGas is blending the pipeline natural gas with trucked in high quality methane at about seven CNG fueling stations to ensure that the CNG supplied to motor vehicles meets the fuel specifications. A blend gas transport vehicle delivers high quality methane to the fueling stations on a weekly basis. This blend gas is mixed with the pipeline gas at the time of fueling. As discussed in Chapter IV, SoCalGas's ability to manage the fueling stations is limited by the blending gas transport vehicle and the local restrictions at the blend gas production site.

In the Los Angeles Basin, local produced associated gas is diluted with high quality gas in the pipeline and has not required blending at the fueling stations. However, due to changes in the State's natural gas demand, more gas from the SSJV is being shipped south into the Los Angeles Basin. Industry is currently evaluating several mitigation measures to ensure that natural gas used for motor vehicles in the Los Angeles Basin complies with the specifications. These include additional processing by producers and blending in the gas company distribution system.

b. Can the industry continue to comply by blending CNG at fueling facilities?

The current practice of blending has several drawbacks, and is not the most desirable option for an extended period.

SoCalGas is operating a unique blend truck, which can take uncompressed natural gas and compress it as it loads. This enables them to transport a larger quantity of gas per load. In addition, this truck can maintain the compression as it off loads the gas into storage tanks. The current process can only service seven fueling stations.

In addition, county restrictions at the gas site that produces the blend gas limit the number of loads per day. Therefore, no additional fueling stations can be serviced with high quality gas from this site. SoCalGas has over twenty applications for additional fueling stations that are currently on hold. The proposed amendments would provide the needed supply of motor vehicle

CNG fuel for these additional fueling sites to operate, thus allowing the CNG vehicle fleet to expand.

c. Are the proposed specifications technologically and commercially feasible?

Yes, the proposed amendments are technologically and commercially feasible. The proposed CNG amendments add compliance flexibility to the regulations and are not mandatory. The existing fuel specifications are not affected and may be still used in place of the alternative specifications. Measures to comply with the existing fuel specifications can be used to meet the proposed amendments.

d. Do the proposed amendments affect the motor vehicle certification fuel?

The proposed amendments do not affect the certification fuel specifications, nor how engine manufacturers comply with engine certification standards.

e. How will CNG fueling stations comply with the proposed standards?

The proposed amendments are optional and do not impose additional requirements beyond those in the current regulation; in fact the proposed amendments provide additional compliance flexibility. Currently, fueling station owners need to ensure that their stations provide CNG that meets the CNG fuel specifications. The current fuel specifications are approximately equivalent to the proposed CNG MN 80 specification. However, due to the non-complying status of some of the CNG produced in the SSJV and SCC, industry will need to continue to take affirmative efforts to provide a source of complying CNG.

The industry is considering several measures to provide complying CNG. As mentioned, gas blending at fueling stations has been used, but may have logistic issues that would limit its wide application and long term feasibility. SoCal Gas has also used in-pipeline blending to improve the quality of natural gas, but this is limited by the pipeline infrastructure and availability of high quality pipeline gas for blending.

Recently, some producers are now evaluating gas treatment options that would improve gas quality at the producers level. Some producers are considering moderate to major gas treatment improvements depending on their current facility configurations and volume of gas production. Also being considered is the repowering of older CNG vehicles in the SSJV and SCC. This would lessen the need to treat all of the gas produced in the SSJV and SCC. Staff estimates that if most of the major gas producers met the proposed MN 80 specifications, gas quality in the SSJV, SCC, and the Los Angeles Basin would be maintained at a level to be protective of existing and new CNG vehicles, without significant effort on the part of small producers.

f. What should be considered when siting future CNG fueling stations to avoid gas quality issues?

The proposed amendments would establish a CNG specification of MN 80 statewide and a MN 73 option in a limited region in California. Generally, while the vast majority of potential sites will not have any fuel quality issues, potential fleet operators should coordinate with their gas provider to determine the quality of fuel that is available. Staff has identified small pockets

of gas production in the Los Angeles Basin that do not meet the MN 80 specification. This gas production does not currently affect existing CNG fueling stations, but can potentially impact future fueling stations if located in the close proximity of these pockets. Thus, potential fleet operators in coordination with the gas provider should consider the quality of gas available in selecting future fueling sites.

For the region where the MN 73 option is allowed, potential fleet operators should coordinate with their gas service provider to determine the quality of fuel that is available and the appropriate technology vehicles that can be fueled with the fuel.

g. How will the ARB enforce the Alternative Fuels Regulations?

The proposed amendments will not change the ARB's enforcement practice. ARB enforcement staff will test the fuel at the fueling stations, to determine compliance. If the fuel is being used to fuel motor vehicles and does not comply with the motor vehicle specifications, ARB staff will attempt to determine which of the parties that are responsible for supplying the fuel that is in violation of the alternative fuels regulations.

5. Impacts of the Proposed CNG Amendments

a. Emission Impacts

1) How will the proposed amendments affect exhaust emissions?

Test results show that for dedicated light-duty NGVs, large variations in fuel composition produced only slight variations, both increases and decreases, in emissions and driveability. Also, bi-fuel vehicles had only modest changes in emissions and performance with changes in CNG quality.[5, 6] Heavy-duty vehicle test data shows that fueling advanced generation engine technologies with MN73 fuel produces no discernible impact on the particulate matter (PM) and oxides of nitrogen (NOx) emissions when compared to emissions from higher quality fuels with MN greater than 80. There were very small increases in carbon dioxide (CO_2) and non-methane hydrocarbon (NMHC) emissions.

2) How do CNG exhaust emissions compare to diesel exhaust emissions?

Typical in-use diesel PM emissions from buses without after-treatment represent a three- to five-fold increase over typical PM emissions from CNG buses using compliant motor vehicle fuel. On average, NOx emissions from diesel buses are greater than NOx emissions from CNG buses.[7]

3) What potential emissions impacts may result if the proposed amendments are not adopted?

The limited availability of motor vehicle grade CNG in the SSJV and SCC has resulted in the potential conversion of several diesel fleets to CNG fleets and fueling sites being postponed. In some cases, proponents have elected to remain with diesel vehicles since there is no certainty in

the availability of motor vehicle grade CNG in these regions. In cases where diesel is elected over CNG vehicles, exhaust emissions of NOx and PM will be likely higher.

The amendments should help make CNG more widely available for vehicles, thus enabling greater use of CNG vehicles. Such greater use would reduce emissions because, overall, CNG fueled vehicles emit less than the diesel vehicles they replace.

b. Economic Impacts

1) What economic impact do the proposed amendments create?

There will be no new mandated costs associated with the proposed amendments to the CNG motor vehicle specifications. These amendments provide additional flexibility to the specifications and allow more cost effective options to comply with the regulations. The proposed amendments for CNG will facilitate further expansion of CNG fueling sites and CNG vehicles.

Although the proposed amendments do not directly impose new costs to industry, there will likely be costs associated with industry ensuring that the quality of fuel that is shipped to the Los Angeles Basin meets an MN 80 specification. As discussed earlier, some gas producers are considering gas treatment options to improve the quality of the gas. These options will have cost associated with their implementation.

c. Environmental Impacts

1) What impact do the proposed amendments have on public health and the environment?

The proposed amendments to the CNG motor vehicle fuel specifications would cause no significant adverse impact to either the public health or the environment.

As discussed earlier, the proposed CNG amendments will not significantly impact motor vehicle exhaust emissions from vehicles now using CNG. The proposed amendments would allow more variability in the motor vehicle CNG fuel formulations, but the fuel constituents and fuel processing methods already in use would remain the same. The proposed amendments would allow gas producers to shift the ratio of fuel constituents while still maintaining a minimum methane number. More of some constituents would be allowed to remain in the motor vehicle fuel rather than be extracted and added to another fuel (e.g., LPG). Therefore, there is no increase or decrease in fuel constituents that are released to the environment (e.g., air, water, or land).

2) Do the proposed amendments affect the commitments in the SIP?

The proposed CNG amendments will not have any impact on the State Implementation Plan measures because these fuel specifications are not a SIP strategy.

3) How will the proposed amendments affect greenhouse gases?

The CNG amendments are not expected to significantly increase emissions of greenhouse gases (GHG). Although there is a small increase in carbon dioxide emissions from using MN 73 versus MN 80, the use of MN 73 CNG is expected to be minimal since most of the CNG produced in the SSJV and the SCC is anticipated to comply with MN 80 CNG specification. Therefore, no significant impact on GHG is expected from the proposed amendments.

6. Future CNG Activities

The proposed CNG amendments provide increased compliance flexibility that will increase the availability of motor vehicle grade CNG. This will facilitate the continued use and expansion of the existing CNG fleets, maintain the emissions benefits of CNG vehicles, and improve the expansion of the CNG market. However, to address the need for future emission control strategies to meet the federal and State ambient air quality standards, it may be necessary in the future to re-evaluate the CNG motor vehicle fuel specifications. Specifically, future motor vehicle exhaust emissions standards may require the cleanest fuels available. Therefore, CNG as well as other alternative fuels may need to be further refined to accommodate future engine technologies and vehicle exhaust emission standards.

C. Liquefied Petroleum Gas

1. Summary of Proposed LPG Amendments

a. Why is staff proposing amendments to the alternative fuels regulations for LPG?

Staff is proposing amendments to the alternative fuels regulations for LPG to increase compliance flexibility. In Northern California, the quality of LPG varies significantly and ranges from LPG meeting the commercial specifications (residential and commercial use) to LPG meeting the more stringent motor vehicle fuel specifications. Because both fuels are handled in a single distribution system, issues arise regarding the delivery of these fuels in small transport trucks ("bobtails") that operate on the same fuel as they deliver. In the case where the delivery fuel does not meet the motor vehicle fuel specifications, the use of this fuel to operate the truck may be in violation of the LPG motor vehicle specifications in the alternative fuels regulations.

Discussions with LPG distributors regarding the historical use of non-motor vehicle LPG in bobtails indicates that bobtails experience satisfactory engine performance although some higher engine maintenance may exist with using off-specification LPG fuel. LPG distributors have long accepted possible increased service frequencies and recognize the potential invalidation of engine warranties may result with the use of off-specification LPG fuel.

b. What amendments to the alternative fuels regulations are being proposed?

Staff is proposing to add an exemption for LPG delivery vehicles that deliver and operate on the same LPG cargo fuel. These vehicles would be allowed to operate on commercial grade or motor vehicle grade LPG.

2. Effects of the Proposed LPG Amendments

a. Who will be affected by the amendments?

The proposed LPG amendments will aid the marketers, suppliers, retailers, and end-users by allowing bobtails to operate without violating the motor vehicle LPG specifications.

b. How will the proposed amendments affect fuel quality?

The proposed exemption from the LPG motor vehicle specifications applies only to bobtail trucks used to transport LPG to distribution and marketing facilities. Bobtails are small transport trucks that operate on the cargo fuel. This exemption will only affect the fuel quality that bobtail vehicles use. All other vehicles are required to operate on LPG that meets the motor vehicle fuel specifications. Bobtail vehicles would therefore be allowed to run on either commercial or motor vehicle grade LPG.

c. How will the proposed amendments affect the availability of fuel?

The proposed LPG amendments will facilitate the delivery of commercial LPG fuel to non-motor vehicle accounts. However, the proposed amendments will have no effect on the supply of motor vehicle LPG fuel.

d. How will these proposed amendments affect engine performance?

Bobtails in Northern California have been satisfactorily operating on commercial grade LPG fuel for the last ten years. The proposed amendments would not change the current operational practices of bobtail owners. Although engine manufacturers believe that additional maintenance may be necessary for vehicles operating on commercial grade fuel due to potential injector and vaporizer deposits, only a few fleet owners indicate that increased maintenance is necessary. Many fleet owners operate bobtails in both Northern and Southern California. Fleet owners claim that when comparing their Northern California and Southern California bobtail truck engines (Southern California vehicles typically operate on motor vehicle grade LPG), the Northern California bobtail engines have not experienced any increased performance or durability problems. [8]

3. Regulatory Development Process and Evaluation of Alternatives

a. What process did the ARB staff use to develop the proposed amendments?

The staff developed the proposed LPG amendments with the participation of several stakeholders that included vehicle fleet owners, LPG fueling station owners, engine manufacturers, refineries, LPG brokers, and LPG suppliers.

Staff held numerous teleconferences and meetings with refiners to discuss their ability to comply with the motor vehicle LPG specifications and how future refinery modifications may impact compliance. The staff held several conference calls and meetings with the associations, LPG suppliers, and brokers to understand the limitations of the current LPG distribution system.

Staff held a public workshop at the start of the process to solicit comments and identify stakeholders. Staff plans to conduct a second public workshop after the release of the staff report to discuss the proposed amendments to the LPG motor vehicle fuel specifications.

b. What other alternatives were evaluated?

The LPG amendments are being proposed to add more flexibility and increase the supply of these fuels for motor vehicles. The alternative would be to not amend the existing regulations.

4. Compliance with the Proposed LPG Amendments

a. How is the industry complying with the current LPG standards?

Southern California refineries generally comply with the LPG motor vehicle fuel specifications, but in Northern California, only one refinery consistently complies. Of the four remaining Northern California refineries, only two are currently selling LPG (with quality ranging from commercial to motor vehicle grade LPG), one refiner is using its LPG onsite, and the other is not producing LPG at all. Also, LPG produced from gas plants and imported LPG generally meet the motor vehicle fuel specifications.

While most large transport trucks have cargo tanks and separate fuel tanks from which they operate, many of the some smaller transport trucks, "bobtails", operate on the same cargo fuel they carry. Bobtails typically transport LPG from intermediate storage facilities to the end-users (e.g. residential users, industrial/commercial users, and agricultural users). Many of the end users are in rural areas that are not accessible by the larger transport trucks and can only be supplied by bobtails. Since Northern California refineries produce both commercial and motor vehicle LPG and the industry's infrastructure is not designed with dual fuel storage capability, bobtails may intermittently operate on commercial grade LPG when delivering fuel to non-motor vehicle accounts.

Staff has been working with the industry to evaluate several options available to facilitate compliance. However, based on the limited availability of complying motor vehicle grade LPG in Northern California, equipping bobtails with separate fuel tanks would not ensure compliance. Thus, staff is proposing an exemption for these delivery trucks. If the proposed amendments are not adopted, bobtails would likely be converted to operate on diesel fuel. As discussed in section 5.a, conversion to diesel would increase PM emissions beyond that experienced from bobtails operating on commercial grade LPG fuel.

5. Impacts of the Proposed LPG Amendments

a. Emission Impacts

1) How will the proposed amendments affect exhaust emissions?

Test results with LPG heavy-duty vehicles show that off-specification LPG (20 percent propene as compared to the LPG specification of 10 percent propene) will increase NOx emissions by about 14 percent when compared to motor vehicle grade LPG. This increase, however, is still

within original vehicle emission certification standards since these vehicles were originally certified on diesel. There is no significant impact on other emissions.

2) How do LPG exhaust emissions compare to diesel exhaust emissions?

Most LPG bobtails were originally certified to diesel engine certification emissions standards. Although potentially cleaner, the overall ozone forming potential of the emissions from LPG bobtail conversions are comparable to their diesel counterparts. However, PM emissions from LPG bobtails are significantly lower than from diesel vehicles.

3) What potential emissions impacts may result if the proposed amendments are not adopted?

If LPG bobtail delivery trucks are not allowed to operate on commercial LPG, these trucks will need to be equipped with separate fuel tanks to run on a legal motor vehicle fuel. Although motor vehicle grade LPG would be the preferable fuel, gasoline or diesel fuel would likely be chosen due to the limited availability of complying LPG. In this case, running on gasoline or diesel fuel would likely increase emissions.

b. Economic Impacts

1) What economic impact do the proposed amendments create?

There will be no new costs associated with the proposed amendments to the LPG motor vehicle specifications. These amendments provide additional flexibility to the specifications and allow a more cost effective option to comply with the regulations.

c. Environmental Impacts

1) What impact do the proposed amendments have on public health and the environment?

The proposed amendments to the LPG motor vehicle fuel specifications would cause no significant adverse impact to either the public health or the environment.

The proposed amendments to the LPG motor vehicle fuel specifications would not change either fuel constituents or fuel processing methods. It would allow bobtail delivery vehicles to use commercial and motor vehicle grade LPG. As discussed, the use of commercial LPG in these vehicles could result in a moderate increase in NOx emissions. However considering there are only about 500 bobtail delivery trucks in Northern California that are likely to use commercial LPG intermittently, staff believes there would be little impact on public health or the environment.[8] As discussed earlier, if these vehicles are not allowed to run on commercial LPG, they would likely convert back to gasoline or diesel fuel and would increase emissions above existing levels.

2) Do the proposed amendments affect the commitments in the SIP?

The proposed LPG amendments will not have any impact on the State Implementation Plan measures because these fuel specifications are not a SIP strategy.

3) How will the proposed amendments affect greenhouse gases?

The LPG amendments are not expected to significantly increase emissions of greenhouse gases (GHG). Therefore no significant impact on GHG is expected from the proposed amendments.

II. Recommendation

The staff recommends that the Board adopt the proposed amendments to the Board's alternative fuel regulations as contained in Appendix A with the recognition that staff may propose some modifications to the proposal based on information and comments obtained subsequent to the release of the Staff Report and prior to the Board hearing in February 2002.

III. Background

This section provides background on the alternative fuels regulations.

A. Alternative Fuels Regulations

The ARB alternative fuels regulations, adopted in 1992, include specifications for seven alternative fuels that are shown below:

- M-100 (100 volume percent methanol)
- M-85 (Nominally 85 volume percent methanol and 15 volume percent unleaded gasoline)
- E-100 (100 volume percent ethanol)
- E-85 (Nominally 85 volume percent ethanol and 15 volume percent unleaded gasoline)
- CNG (Compressed Natural Gas)
- LPG (Liquefied Petroleum Gas)
- Hydrogen

The regulations include specifications for certification fuels for certifying new vehicles and specifications for commercial fuels for in-use vehicles. The specifications were developed in anticipation that alternative fuels would be used by engine manufacturers to design vehicles to meet the increasingly stringent low emission vehicle (LEV) standards. The certification specifications provide engine manufacturers with fuel quality specifications to design and certify engines. The commercial specifications (which are the sole subject of the proposed amendments) define the fuel that is used by motor vehicles operated in California. The commercial specifications ensure that in-use fuels are similar to the fuels used to certify new vehicles and engines, and to ensure the fuel quality in the market place to protect engines and maintain the emissions benefit of alternative fuels. The following sections discuss the commercial CNG and LPG motor vehicle specifications.

B. Compressed Natural Gas

The motor vehicle specifications for CNG were developed in consultation with the natural gas industry, the automobile industry, the engine manufacturers, and other interested parties. The specifications developed were based on a consensus of the quality of natural gas that was imported and produced in California. The motor vehicle CNG specifications are contained in the California Code of Regulations (CCR), title 13, section 2292.5 and are shown in Table III-1. The CNG specifications have not been amended since their original adoption.

Table III-1: Motor Vehicle CNG Specifications

Specifications		Value
Hydrocarbons (expressed as mole percent)	Methane	88.0% (min.)
	Ethane	6.0% (max.)
	C3 and higher HC	3.0% (max.)
	C6 and higher HC	0.2% (max.)
Other Species (expressed as mole percent unless otherwise indicated)	Hydrogen	0.1% (max.)
	Carbon Monoxide	0.1% (max.)
	Oxygen	1.0% (max.)
	Inert Gases (Sum of CO_2 and N2)	1.5-4.5% (range)
	Sulfur	16 ppmv (max.)
	Water	a
	Particulate Mater	b
	Odorant	c
[a]The dewpoint at vehicle fuel storage container pressure shall be at least 10°F below the 99.0% winter design temperature listed in Chapter 24, Table 1, Climatic Conditions for the United States, in the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Handbook, 1989 fundamentals volume. Testing for water vapor shall be in accordance with ASTM D 1142-90, utilizing the Bureau of Mines apparatus.		
[b]The compressed natural gas shall not contain dust, sand, dirt, gums, oils, or other substances in an amount sufficient to be injurious to the fueling station equipment or the vehicle being fueled.		
[c]The natural gas at ambient conditions must have a distinctive odor potent enough for its presence to be detected down to a concentration in air or not over 1/5 (one-fifth) of the lower limit of flammability.		

C. Liquefied Petroleum Gas

Like other alternative fuel specifications, the motor vehicle specifications for LPG were adopted in consultation with the LPG industry, automobile industry, the engine manufacturers, and other interested parties. The specifications were developed using two established references as guides. The first is the Gas Producers Association (GPA) Standard 2140, which contains recommended specifications for motor vehicle LPG fuel (referred to as "heavy-duty-5" or HD-5). These specifications require a fuel composition of "not less than 90 liquid volume percent propane…[and] not more than 5.0 liquid volume percent propene." The second reference is the American Society of Testing and Materials (ASTM) Designation D1835-89, which has set specifications for "special-duty LPG" to be consistent with the HD-5 specifications set by the GPA.

When the regulations were adopted, the Board set an interim limit of 10.0 volume percent propene and a minimum 80.0 volume percent propane content requirement, applicable from

January 1, 1993 through December 31, 1994. Starting on January 1, 1995, the propene content is limited to a maximum value of 5.0 volume percent and the minimum propane content is increased to 85.0 volume percent. Thus, the Board's specifications for LPG for use in vehicles is very similar to HD-5, differing only in the minimum propane content. The Board adopted the 5.0 volume percent propene requirement to limit the reactivity of exhaust emissions because propene is more reactive in the atmosphere than propane. However, the Board provided a two-year delay because LPG fuel proponents expressed concerns that LPG fuel meeting the 5.0 volume percent propene requirement would not immediately be available.

In 1994, the Western Propane Gas Association (WPGA) petitioned the Board to continue the interim 10 volume percent propene requirement because of concern that there was no reliable supply of 5 volume percent propene fuel. In response, the Board continued the interim 10 volume percent propene requirement until January 1, 1997. Then again in 1996, the WPGA petitioned the Board a second time to further continue the interim propene requirement because of similar supply issues. In response, the Board in 1997 extended the interim requirement until January 1, 1999. In making the second delay of the 5 volume percent propene requirement, the Board stated its intent to grant no further delays. It instructed the staff to seek an alternative to the specifications in section 2292.6 to take effect in 1999 that would provide satisfactory emission control, provide good performance in LPG engines, and be more likely to be met by the LPG produced in the market.

In 1998, the Board adopted the 10 volume percent propene limit as a permanent alternative to the LPG specifications in CCR, title 13, section 2292.6, effective January 1, 1999 after engine test results show minimal emissions increased between a 5 volume percent propene fuel and a 10 volume percent propene fuel. The current motor vehicle LPG specifications are shown in Table III-2. The Board acted to preserve and enhance the current supply of complying fuel to owners of LPG vehicles and to assure adequate emissions performance.

Table III-2: Motor Vehicle LPG Specifications

Specifications	***Value***	***Test Method***
Propane	85.0 vol. % (min.) a/	ASTM D 2163-87
Vapor Press. at 100^{o} F	208 psig (max.)	ASTM D 1267-89 ASTM D 2598-88 b/
Volatility residue: Evaporated temp., 95% or butanes	 -37^{o} F (max.) 5.0 vol. % (max.)	 ASTM D 1837-86 ASTM D 2163-87
Butenes	2.0 vol. % (max.)	ASTM D 2163-87
Pentanes, and heavier	0.5 vol. % (max.)	ASTM D 2163-87
Propene	10.0 vol. % (max.)	ASTM D 2163-87
Residual matter: Residue on evap. of 100 ml Oil stain observed.	 0.05 ml (max.) pass c/	 ASTM D 2158-89 ASTM D 2158-89
Corrosion, copper strip	No. 1 (max.)	ASTM D 1838-89
Sulfur	80 ppmw (max.)	ASTM D 2784-89
Moisture content	pass	ASTM D 2713-86
Odorant	d/	

a/ Propane shall be required to be a minimum of 80.0 volume percent starting on January 1, 1993. Starting on January 1, 1997, the minimum propane content shall be 85.0 volume percent.

b/ In case of dispute about the vapor pressure of a product, the value actually determined by Test Method ASTM D 1267-89 shall prevail over the value calculated by Practice ASTM D 2598-88.

c/ An acceptable product shall not yield a persistent oil ring when 0.3 ml of solvent residue mixture is added to a filter paper, in 0.1 ml increments and examined in daylight after 2 min. as described in Test Method ASTM 2158-89.

d/ The liquefied petroleum gas upon vaporization at ambient conditions must have a distinctive odor potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability.

D. Comparable Federal Regulations

There are no other legally enforceable specifications for CNG and LPG motor vehicle fuels in the United States. The United States Environmental Protection Agency does not have any specifications for motor vehicle CNG and LPG. The Board's specifications for CNG and LPG for use in motor vehicles, as presented in the previous discussion, are the only required specifications for motor vehicle CNG and LPG, respectively.

E. Commercial Standards

In addition to use as motor vehicle fuels, natural gas and LPG are used in industrial, commercial and residential applications. The gas quality for these applications is referred to as commercial grade. The industry has developed fuel standards for commercial grade natural gas and LPG.

There are four general standards that apply to commercial natural gas. These standards were developed mainly for safety reasons. Two of the four are recommended practices and include:

- Society of Automotive Engineers (SAE) J1616, "Recommended Practice for Compressed Natural Gas Vehicle Fuel," issued in February 1994
- National Fire Protection Association (NFPA) 52, "Compressed Natural Gas (CNG) Vehicular Fuel Systems 1992 Edition," issued August 1992.

SAE J1616 and NFPA 52, apply to the design and installation of CNG vehicle fuel systems and fueling dispensing systems.

The other two standards include:

- California Public Utilities Commission (PUC) General Order 58-A, "Standards for Gas Service in the State of California," last revised April 1989
- Individual public utility's contract agreement.

The PUC General Order 58-A and the utilities' contract agreements apply to the safe transport of gas through the pipeline systems. The commercial gas quality standards specified include general limits on such parameters as flammability, water content and other corrosion precursors, energy content, and gas delivery pressure. No restrictions on compositional elements such as methane, ethane, propane and other heavier hydrocarbons are specified.

The commercial LPG standard is the voluntary industry standard for “commercial propane”, which allows up to 50 percent propene content. Table III-3 shows the compositional elements of the commercial propane standard.

Table III-3: Commercial Standard for LPG

Constituent	*Commercial Propane*
Propane	“predominantly propane”
C_4+ (butane & heavier)	< 2.5%
Olefins (e.g., propene)	(no limit)

F. Alternative Fuels Enforcement

Enforcement of the alternative fuels regulations is similar to enforcement of the gasoline and diesel regulations within California. The proposed amendments will not change the enforcement

procedure. ARB staff will test the fuel at fueling stations, to determine compliance. If the fuel is being used to fuel motor vehicles and does not comply with the motor vehicle specifications, ARB staff will consider all of the parties that are responsible for supplying the fuel to be in violation of the alternative fuels regulations. However, chemical analysis speciation data for the fuel at locations in the distribution system upstream of the fueling facility will be considered in assessing liability.

IV. Description and Rationale of the Proposed CNG Amendments

A. Proposed Amendments

Staff is proposing to establish new CNG specifications based on methane number (MN) to provide more flexibility for producers and suppliers of CNG to comply with the specifications. These specifications will be an additional compliance option to the existing specifications. Specifically, staff proposes two additional specifications: a statewide specification of MN 80, and an alternative specification of MN 73 available in the SSJV and SCC to fleet operations that meet the following criteria:

- The natural gas service provider does not provide natural gas that meets an MN of 80 at the service connection;
- The vehicles fueled at the facility are recommended by the engine manufacturer as being able of operating on CNG with a MN of 73; and
- The fueling station has controls in place that will prevent misfueling.

Staff also proposes two definitions that are necessary to define the SSJV and SCC. For the purpose of these specifications, SSJV will be defined as inclusion of the following counties within the jurisdiction of the San Joaquin Valley Air Pollution Control District: Fresno, Kings, Tulare, and Kern counties. The SCC includes San Luis Obispo and Santa Barbara counties.

B. Rationale

1. Feasibility of Meeting the Proposed Alternative Specifications

Staff is proposing amendments to the alternative fuels regulations for CNG to increase compliance flexibility and the availability of complying CNG in California. There are areas in California where the availability of CNG meeting the motor vehicle fuel specifications is very limited. These areas include the SSJV and the SCC where natural gas is produced in association with oil production. This gas or "associated gas" typically does not meet the motor vehicle fuel specifications for CNG. But because this gas meets the commercial quality specifications for natural gas, it is allowed to enter the common pipeline that supplies natural gas to residential, commercial, industrial, and motor vehicle end-users. Therefore, SSJV and SCC gas that is drawn off the pipeline in these areas for motor vehicle CNG use may exceed the CNG motor vehicle specifications and would be considered a non-compliant fuel.

Methane number (MN) for CNG is similar to the octane number used in gasoline. Like octane number, MN provides an indication of the knock tendency of the fuel. MN can be calculated from the fuel composition as demonstrated in Appendix D. The primary benefit from using MN is the flexibility it provides in allowing the CNG composition to vary. A producer can improve gas quality by choosing which fuel components to reduce or remove. The heavier or higher carbon chain components are easier to remove and have a greater adverse influence on the MN than the lighter components. Thereby a reduction of the heavier components will have a larger positive impact on the MN (improvement in gas quality) than the lighter components.

Based on this, staff has determined that alternative CNG specifications using the methane number index would provide more compliance flexibility with the regulations. By providing additional compliance options, the proposed amendments allow gas suppliers to tailor modifications to their facilities, which will enable them to comply with the specifications easier; thereby, increasing the availability of motor vehicle grade fuel.

2. Performance

The proposed MN 80 will not cause performance or durability concerns with existing and new technology engines. Existing engines (open-loop and first generation closed-loop technology) were designed to handle the existing CNG motor vehicle fuel specifications (about MN 80 to 82). Engine manufacturers agree that these existing engine technologies can properly operate on CNG with a methane number of at least 80. Also, major engine manufacturers agree that the newer advanced technology engines can operate on a broader range of fuel quality. These engines can properly operate on CNG with a methane number as low as 73.

3. Supply

The proposed amendments would increase the amount of fuel available for use as motor vehicle fuel by providing more flexibility to comply with the regulations. Currently, 89 percent of the statewide supply of CNG is in compliance with the existing motor vehicle fuel specifications. The proposed MN 80 specification would increase this amount to about 91 percent by increasing the amount of CNG that would comply in the SSJV and SCC.[9]

In the SSJV and the SCC where most associated gas production occurs, almost all of the CNG supply in these regions does not comply with the existing motor vehicle fuel specification. The proposed MN 73 specification would increase the local supply of complying CNG to about 88 percent in the SCC and 99 percent in SSJV.[9] In this area, only a relatively small number of current technology vehicles exist using about seven fueling facilities. Since future growth in CNG vehicles will be new technology vehicles, it is feasible for these regions to accommodate an MN 73 CNG specification.

In the Los Angeles Basin, no impact on CNG supply is expected to occur since essentially all of the gas used for motor vehicles use comes from clean imported sources. Also, since this region has a significant amount of existing technology vehicles that require a MN 80 fuel, staff is not recommending the allowance of a MN 73 fuel.

4. Emissions

The proposed amendments would have no significant adverse impact on mass emissions from CNG vehicles. The proposed MN 80 specification is very similar to the existing CNG motor vehicle fuel specifications. Test data on light and heavy-duty engines using MN 80 CNG shows no impact on emissions from fuel meeting the current CNG motor vehicle fuel specifications. Regarding the proposed MN 73 specification, test data on light-duty vehicles shows only minimal effects on emissions, both increases and decreases, as summarized in Table IV-1[5]. For advanced technology closed loop heavy-duty vehicles, test data shows no discernable impact on PM and NOx emissions and only a slight impact on CO_2 and NMHC emissions (as summarized in

Table IV-2[10]). A complete discussion on the fuel effects on emissions is discussed in Chapter VII and Appendix B.

Table IV-1: Range of emissions by pollutant for MN 89 and MN 63 CNG for Light-Duty Dedicated NGVs

Pollutant	MN 89 CNG (g/mi)	MN 63 CNG (g/mi)
CO	0.46 – 1.26	0.29 – 1.48
NOx	0.09 – 0.17	0.05 – 0.20
NMOG	0.016 – 0.027	0.012 – 0.030

Table IV-2: Range of emissions by pollutant for MN 80 and MN 73 CNG for Advanced Technology Heavy-Duty NGVs

Pollutant	MN 80 CNG (g/mi)	MN 73 CNG (g/mi)
CO	0.2 – 4.2	0.2 – 4.2
PM	0.009 – 0.029	0.008 – 0.031
THC	7.5 – 7.9	7.5 – 8.2
NOx	6.9 – 12.8	6.1 – 11.0
NMHC	1.3 – 2.7	1.5 – 3.0
CO_2	944 – 1020	978 – 1077

The proposed amendments will help to ensure the continued emission benefits of CNG fueled vehicles. As discussed in Chapter VII, typical in-use diesel PM emissions from buses without after-treatment represent a three- to five-fold increase over typical PM emissions from CNG buses using compliant motor vehicle fuel. On average, NOx emissions from diesel buses are greater than NOx emissions from CNG buses.[7]

C. Future CNG motor vehicles fuel specifications

The proposed amendments provide increased compliance flexibility that will increase the availability of motor vehicle grade CNG. This will facilitate the continued use of the existing CNG fleets, maintain the emissions benefits of CNG vehicles, and improve the expansion of the

CNG market. However, to address the need for future emission control strategies to meet the federal and State ambient air quality standards, it may be necessary in the future to re-evaluate the CNG motor vehicle fuel specifications. Specifically, future motor vehicle exhaust emissions standards may require the cleanest fuels available. Therefore, CNG as well as other alternative fuels may need to be further refined to accommodate future engine technologies and vehicle exhaust emission standards. The MN 73 specification may be temporary.

V. Description and Rationale of the Proposed LPG Amendments

A. Proposed Amendments

Staff is proposing to add a provision allowing small local delivery trucks, which deliver LPG fuel to non-motor vehicle accounts an exemption from the LPG motor vehicle specifications. Small local delivery trucks or "bobtails" are defined as a truck capable of being fueled off of the cargo tank with a maximum capacity of 3000 gallons. These vehicles would be allowed to operate on commercial grade LPG.

B. Rationale

1. Performance

Bobtail trucks transport fuel to non-motor vehicle and motor vehicle accounts. Although some bobtail trucks have a side-saddle fueling tank, many do not, and they fuel on the same cargo fuel that they are delivering. These trucks have operated intermittently on off-specification fuel for the last ten years. Although engine manufacturers believe that additional maintenance is necessary to maintain engine performance and fuel economy, only a few fleet owners have indicated that additional maintenance is necessary. According to the suppliers, marketers and fleet owners of bobtail trucks, the trucks have not had any durability or engine performance problems over the last ten years. In addition, vehicle testing demonstrates that engine performance was unaffected by fuel blends, and no abnormal wear to the engine was detected. Additional detail on the testing programs is discussed in Chapter VIII and Appendix C.

2. Supply

These proposed amendments will not affect the supply of motor vehicle grade LPG.

3. Emissions

When comparing emissions from heavy-duty vehicles operating on the current motor vehicle specification LPG to commercial grade LPG fuel, NMHC emissions decrease by 11 percent, CO emissions decrease by 20 percent, and NOx increase by 14 percent. However, the NOx emissions increase is still within the original vehicle emission certification standards, since these vehicles were originally certified on diesel.

When compared to diesel, vehicles operating on commercial LPG have significantly less PM emissions. If bobtails were to convert back to diesel, PM emissions could potentially increase above existing levels. To prevent this from occurring, we believe it is necessary to include this exemption. Additional information can be found in Chapter IX and Appendix C.

VI. Discussion of Compressed Natural Gas as a Motor Vehicle Fuel

A. Overview of CNG as a Motor Vehicle Fuel

Compressed natural gas (CNG) is a highly compressed form of the natural gas. Natural gas is a combustible, gaseous mixture primarily composed of methane (CH4), with small amounts of ethane (CH6), propane (C3H8), butane (C4H10) and pentane (C5H12). Natural gas is produced either from gas wells which do not produce any crude oil (non-associated gas) or in conjunction with crude oil production (associated gas). In California, associated gas is produced within the southern half of the state.

In California, natural gas is distributed in an extensive pipeline system that extends from the well-head to the end user. The pipeline system consists of long-distance transmission lines, operating at 250 to 1,000 pounds per square inch gauge (psig) pressure, which transfer natural gas from a gathering line (production facility) or storage facility to a distribution center or another storage facility. From there, natural gas is distributed by local distribution lines to customers through either a 60-psig high-pressure distribution system or a low-pressure system that delivers natural gas to a residential gas meter at 1/4 psig.

The natural gas pipeline also serves as the source for CNG. At strategically located CNG fueling outlets, natural gas is pulled off the pipeline and is compressed to 3,000 to 3,600 psig for motor vehicle use.

CNG fueling outlets are provided by natural gas utilities and through a limited number of major gasoline retailers and independent CNG retailers. In California, the utilities include the City of Long Beach Gas Department, Pacific Gas and Electric (PG&E), San Diego Gas & Electric, and SoCalGas. These companies do not produce or own the gas but are the service providers that own and maintain the pipeline infrastructure that delivers the gas.

As of July 2001, there are 212 CNG fueling sites in existence throughout California. More than half of these compressor stations have full or limited access to the public, providing both "time-fill" (slow-fill requiring two to three hours to refuel) and "fast-fill" (quick-fill requiring two to five minutes) systems. In addition, individual home compressors are also available which use a time-fill system for overnight refueling. A small compressor is usually located in a home's garage area and connected directly to the natural gas supply to the house.[11]

B. Current Gas Quality Issues

In 1999, about 16 percent of the natural gas used in California was produced in the State and 84 percent was imported from the Rockies and the southwestern United States, and Canada. The natural gas imported into California generally meets the existing specifications for CNG motor vehicle fuel. Of the 16 percent of the natural gas produced in California, about 72 percent is associated gas (gas produced in association with oil production) which can vary widely in properties.[12] Generally, the ethane content and the propane and heavier hydrocarbons content (referred to as C3+) of associated gas can often exceed the levels in the CNG motor vehicle fuel specifications but meet the pipeline specifications for commercial natural gas. The remaining 28 percent of total California production of natural gas is non-associated gas (gas produced from gas

wells which do not produce any crude oil) which is high in methane content and normally meets the existing motor vehicle CNG specifications.

As discussed previously, natural gas produced in Northern California is non-associated gas. In addition, natural gas supplied to Northern California is imported gas from out-of-state. Thus, fuel quality is not an issue in Northern California.

Production of associated gas is concentrated in the SSJV and SCC region. Generally, the associated gas in the SSJV tends to have a greater ethane content than the specifications for CNG motor vehicle fuel. The associated gas in the SCC almost meets the ethane content, but it exceeds the C3+ content. Table VI-1 compares the CNG motor vehicle fuel specifications to the pipeline gas in the SSJV and SCC.

Table VI-1: Comparison of Existing CNG Motor Vehicle Fuel Specifications to Pipeline Gas in Southern San Joaquin Valley (SSJV) and South Central Coast (SCC)

Component	*SSJV Pipeline Gas*		*SCC Pipeline Gas*		*Motor Vehicle Specifications*
	Average	*Range*	*Average*	*Range*	
Methane (mole%)	86.0	79-97	88.5	86-97	88.0 min.
Ethane (mole%)	8.9	0-12	5.2	0-8	6.0 max.
C3+ (mole%)	2.7	0-9	3.8	0-6	3.0 max.
Inerts (mole%)	2.4		2.5		4.5 max.
CO_2	1.9	2-3	2.0	2-3	
N2	0.5	0-1	0.5	0-1	
BTU	1100	990-1181	1095	990-1141	N/A

As can be seen in Table VI-1, there is a significant variation in natural gas quality in both regions. The volume-weighted average for the SJV region is about 9 mole percent ethane with the ethane content varying significantly from almost none to as high as 12 mole percent. The volume-weighted average for the SCC region is 3.8 mole percent C3+ with the C3+ varying from almost none to as high as 6 mole percent.[13]

Historically, producers have not processed or treated their natural gas to meet the CNG motor vehicle specifications. In California a market does not exist for ethane. As a result, most gas plants are not equipped for or designed to extract ethane. In other parts of the country, ethane is extracted from natural gas because it is marketed for use in the petrochemical industry. In

California, the only likely use for ethane is as an onsite fuel but many facilities may not have enough demand to absorb all of the ethane that would be extracted.

In contrast, a market does exist for propane in California. However, the demand for propane is seasonal (i.e., high in the winter for home heating - see LPG section for further discussion). As discussed in the previous section, heavier hydrocarbons that naturally accompany associated gas as it leaves the ground include ethane, propane (LPG), butane, and pentane. Because propane boils at -44 degrees Fahrenheit and ethane boils at -127 degrees Fahrenheit, less processing is needed to separate propane than ethane. Generally, the heavy gases are removed from the raw natural gas stream, leaving mostly methane before entering the natural gas pipeline distribution system. The removal of the heavy gases is refers to as liquid extraction or liquid recovery. Producers in SSJV and SCC do have limited capacity to extract propane and heavier hydrocarbons from the natural gas. However, additional propane extraction or recovery has economic tradeoffs. Producers will run their systems to maximize propane recovery if the liquid sale can make up the operational cost.[14]

As noted above, the ethane content in the SJV region and the C3+ content in SCC region exceed the levels allowed by the CNG motor vehicle fuel specifications. Because associated gas is regionally produced, most of this gas is consumed locally with no opportunity to be diluted with higher quality gas in the pipeline. Thus, gas that is drawn off the pipeline in these areas for motor vehicle CNG use typically does not meet the CNG specifications. Currently, SoCalGas, the main service provider for Southern California, is blending the pipeline gas with high quality gas that is trucked to various NGV fueling stations in the affected regions to ensure that the CNG supplied to motor vehicles meets the motor vehicle CNG specifications. However, SoCalGas's ability to manage the fueling stations is limited by the blending gas transport vehicle and the local restrictions on pick-up and delivery at the blend gas production site.

The current gas quality issues in these regions have prevented the expansion of additional CNG re-fueling stations. Presently, there are about twenty (20) businesses that have applied to the utilities for the installation of CNG re-fueling stations. These requests have been put on hold because the utilities are not certain that they will be able to provide the stations with motor vehicle grade CNG.

During the recent energy crisis in California, there has been an increase in natural gas production in the San Joaquin Valley. Also, changes in supplier contracts have resulted in decreased demand in the region. These events have resulted in an increase in migration of SJV produced associated gas to the Los Angeles basin. As discussed, this gas meets the pipeline quality standards, but does not comply with the motor vehicle specifications for CNG. The increased migration of this gas could potentially affect CNG fueling sites in the Los Angeles basin.

C. Engine Performance Issues

If allowed to be used in vehicles without treatment or blending to meet minimum specifications, the variation in CNG composition seen throughout the SCC and SSJV can adversely affect engine performance. These effects can include misfire, stumble and underrated operation[15] as well as engine knock and overheating that can lead to possible catastrophic failure. Light-duty engines are less susceptible to these fuel-related performance problems because of the engine

operation controls that have been developed for emissions control. Recent advances in engine controls for heavy-duty engines have resulted in newer heavy-duty engines that are more tolerant of variable fuel quality. However, there is a wide range of heavy-duty CNG engine technologies currently in use in California. The older or less sophisticated heavy duty CNG engine technologies are susceptible to fuel-related performance problems. This vehicle population must be either safeguarded against these problems by ensuring that the engines operate on a minimum quality fuel or replacing the engines with more advanced engine technology.

D. Gas Quality Indices

Two measures of CNG gas quality are the Wobbe Index and the methane number. The Wobbe Index is a measure of the fuel interchangeability with respect to its energy content and metered air/fuel ratio.[16, 17] Thus, changes in Wobbe Index can affect the engine's metered air/fuel ratio and power output.[18] The Wobbe Index is calculated from the energy content of gas (using the higher heating value of the energy content range), and the relative density of the gas. The relative density of the gas is the ratio of the gas density to the density of air.

Wobbe Index = Higher Heating value / (relative density)

The methane number is a measure of the knock resistance of the fuel. Knock, or detonation, can be extremely damaging to an engine. Knock occurs when there is uncontrolled combustion with multiple flame fronts rather than smooth combustion proceeding along a flame front initiated at the spark plug.[19, 20] Knock can result from the heat produced by compression of the air/fuel gas mixture in the piston. The knock resistance of the fuel is a function of the fuel composition. Methane has a very high knock resistance. The heavier hydrocarbons in CNG, such as ethane, propane, and butane, have lower knock resistance and thus reduce the overall knock resistance of the fuel. Methane number and how it is determined in explained in Appendix D. The current CNG motor vehicle fuel specifications equate to a methane number of approximately 80 to 82, depending on the speciation of the C3+ content, as shown in Appendix D.

VII. CNG Engine Types and Fuel Quality Requirements

A. Light-Duty Engines

Light-duty engines are stoichiometric burn engines with three-way catalyst exhaust after-treatment and exhaust feedback control developed to meet light-duty vehicle exhaust emissions standards.[21] Stoichiometric burn engines are designed for an air/fuel ratio that can completely burn the fuel without excess air. Light-duty engines have feedback controls that process information from the exhaust to aid in engine operation. Engines with feedback controls are called closed loop systems. Both the feedback controls used for light-duty engines and their stoichiometric operation make them very tolerant of the natural gas fuel variations seen in California. A survey of light duty vehicle manufacturers indicated that fuel quality requirements for light duty engines are more frequently cited in terms of Wobbe Index. Manufacturer recommended gas quality requirements range approximately from a minimum of 1300 BTU/ft3 to a maximum of 1400 to 1500 BTU/ft3.[18,22] These equate to a minimum methane number of approximately 65 to 70, as discussed in Appendix E.

A test program to determine the effect of fuel quality on emissions and driveability for light-duty vehicles was sponsored by the Gas Research Institute (GRI), Pacific Gas & Electric (PG&E), SoCalGas, Atlanta Gas Light Company (AGL), automakers, and regulatory agencies. This test program is discussed in Appendix B. The test program used eight light-duty natural gas vehicles (NGV) with five different fuel qualities. The tested fuel qualities ranged from a methane number of approximately 65 to 100. Test results showed that for original equipment manufacturer (OEM) dedicated NGVs, even large variations in fuel composition produced only slight variations in the emissions and driveability, both increases and decreases, while bifuel vehicles had only modest changes in emissions and performance.[5,6] This is shown by a comparison of the measured emissions ranges obtained with the MN 89 gas and a MN 63 minimum quality gas given in Table VII-1 below for the OEM dedicated NGVs.

Table VII-1: Range of emissions for MN 89 and MN 63 CNG for OEM Dedicated NGVs

Pollutant	MN 89 CNG (g/mi)	MN 63 CNG (g/mi)
CO	0.46 – 1.26	0.29 – 1.48
NOx	0.09 – 0.17	0.05 – 0.20
NMOG	0.016 – 0.027	0.012 – 0.030

B. Medium-Duty and Heavy-Duty Engines

Medium-duty and heavy-duty engines are usually designed as lean-burn engines because these engines are more fuel-efficient and produce lower combustion temperatures than stoichiometric burn combustion. Lean-burn engines are designed to operate at an air/fuel ratio with more air than required to completely burn the fuel. This engine technology has been used to meet

applicable exhaust emission standards without the use of after-treatment technology. However, as explained in Appendix E, lean-burn engines are more susceptible to problems associated with variable gas quality.

Early CNG lean-burn engines operated without feedback controls. Theses are called open loop systems. Open loop lean-burn engine technology is the least tolerant of variable gas quality. Most CNG lean-burn engines currently being manufactured include closed loop engine technology. Recent advances in lean-burn engine feedback control have made some closed loop heavy-duty engines more tolerant of variable fuel quality than others. The less tolerant closed loop engines will be referred to as first generation closed loop engine technology. Open loop and first generation closed loop engine technologies require fuel with a methane number of 80 or higher. The more advanced engine technology will be referred to as "advanced generation closed loop" engine technology. Advanced generation closed loop engine technologies can tolerate a fuel quality with a methane number as low as 73. Advanced generation engine technology is being successfully used in a number of SSJV and SCC fleets operating on fuel that does not meet the current CNG motor vehicle fuel specifications where a test program exemption has been granted by the ARB. Additionally, there are closed loop engines recently certified by ARB as low emissions engines that can tolerate methane numbers as low as 65.[23] The different engine technologies, i.e. stoichiometric versus lean-burn and open versus closed loop, are explained in more detail in Appendix E.

A test program was sponsored by the Gas Research Institute (GRI), Pacific Gas & Electric (PG&E), SoCalGas, Atlanta Gas Light Company (AGL), automakers, and regulatory agencies to determine the effect of fuel quality on emissions and performance for seven different heavy-duty open and closed loop engine technologies.[10] The results of this testing are summarized in Appendix B. The tested CNG qualities ranged from MN 73 to MN 99. These data showed that fueling advanced generation engine technologies with MN 73 fuel produced no discernible impact on the PM and NOx emissions when compared to measured emissions of the other cleaner fuels, as shown below in Figure VII-1 and Figure VII-2, respectively.

Figure VII-1: Measured PM Emissions versus Methane Number for Advanced Generation Closed Loop Engines

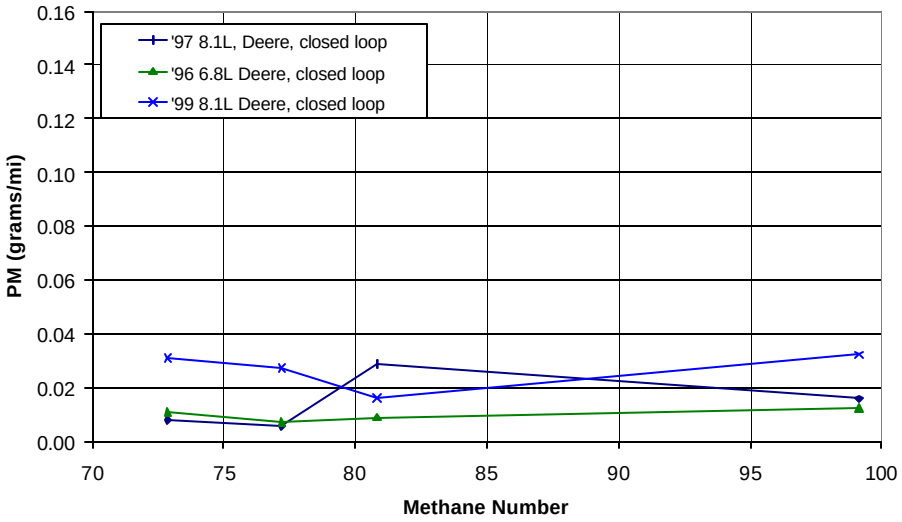
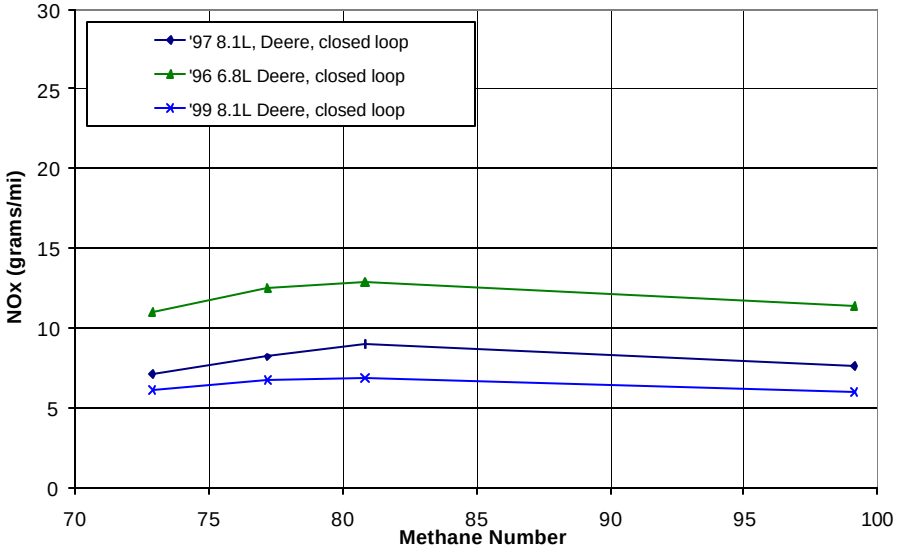


Figure VII-2: Measured NOx Emissions versus Methane Number for Advanced Generation Closed Loop Engines



The measured emissions ranges for the advanced generation closed loop vehicles are summarized in Table VII-2 below for a fuel equivalent in methane number to the current specifications, MN 81, and for a MN 73 fuel. As shown, there were increases in carbon dioxide (CO_2) and nonmethane hydrocarbon (NMHC) emissions of about six percent and approximately 10 percent respectively. There were no discernible impacts on the other emissions.

Table VII-2: Range of emissions for MN 81 and MN 73 CNG for the Tested Advanced Generation Closed Loop Vehicles

Pollutant	**MN 81 CNG (g/mi)**	**MN 73 CNG (g/mi)**
CO	0.2 – 4.2	0.2 – 4.2
PM	0.009 – 0.029	0.008 – 0.031
THC	7.5 – 7.9	7.5 – 8.2
NOx	6.9 – 12.8	6.1 – 11.0
NMHC	1.3 – 2.7	1.5 – 3.0
CO_2	944 – 1020	978 – 1077

C. Industry's Efforts to Address CNG Issues

Currently, industry is considering a combination of market options to address the issues related to off-specification CNG. Options include increased gas processing, continued pipeline blending, and engine re-powering.

Improvements in gas processing at major production sites in the SSJV and the SCC are being considered by the industry. Improvements range from moderate gas plant modifications to installing new gas plant capacity. These improvements would allow major gas producers to meet or exceed a gas quality of MN 80. By significantly improving the gas quality for most of the gas produced in these regions, it may be possible to maintain the average pipeline quality above MN 80.

Pipeline blending is another option that has been used in the past and can be used to provide added assurance that pipeline gas quality is maintained. Specifically, the gas that is sent down to the Los Angeles basin must meet a MN 80 to protect the existing CNG motor vehicle fleet. SoCalGas has indicated that it can monitor the quality of gas at a strategic location on the pipeline and, if necessary, blend in high quality gas to improve the quality of the gas that is sent to the LA Basin. However, blending will displace an equivalent amount of gas and would likely involve some curtailment in the amount of gas that is allowed to enter the pipeline from the

producers in the SSJV and the SCC. SoCalGas is presently discussing the possibility of gas curtailments with gas producers if significant pipeline blending occurs.

Re-powering existing engines in SSJV and the SCC is an option that would facilitate the use of MN 73 CNG in these regions. As discussed, light-duty vehicles and advanced closed-looped technology heavy-duty vehicles can properly operate on MN 73 CNG. However, existing open-looped and first generation closed-looped technology heavy-duty vehicles require MN 80 CNG. Therefore, re-powering these vehicles with advanced closed-looped technology would allow the use of MN 73 CNG in these regions.

To facilitate these industry options, the proposed amendments to the CNG motor vehicle fuel specifications would allow the use of a flexible fuel specification based on methane number. The proposed amendments would also allow the option of an alternative MN 73 specification for vehicles that operate in the SSJV and the SCC.

For future CNG fueling sites, industry will need to consider the quality of the fuel that is available. Generally, while the vast majority of potential sites will not have any fuel quality issues, potential fleet operators should coordinate with their gas provider to determine the quality of fuel that is available. Staff has identified small pockets of gas production in the Los Angeles Basin that do not meet the MN 80 specification. This gas production does not currently affect existing CNG fueling stations, but can potentially impact future fueling stations if located in the close proximity of these pockets. Thus, potential fleet operators in coordination with the gas provider should consider the quality of gas available in selecting future fueling sites.

For the region where the MN 73 option is allowed, potential fleet operators should coordinate with their gas service provider to determine the quality of fuel that is available and the appropriate technology vehicles that can be fueled with the fuel.

VIII. Discussion of Liquefied Petroleum Gas as a Motor Vehicle Fuel

A. Overview of LPG as a Motor Vehicle Fuel

LPG refers to a mixture of light hydrocarbons, predominantly propane, that is pressurized into a liquid for use as a fuel. LPG has uses similar to those of natural gas. In addition to its application as a motor vehicle fuel, LPG is used in space heating (e.g., in rural buildings and recreational vehicles) and portable appliances (e.g., barbecues), as well as heating and cooking in areas where natural gas is not available.

LPG is produced and supplied from oil refineries and by gas plants in oil and gas fields. In refineries, it is a by-product of processes that produce gasoline. At gas plants, LPG is separated from crude oil and from natural gas.

LPG from refineries can contain substantial amounts of propene. The propene content in LPG is partly dependent on a refiner's use of fluidized catalytic cracking units (FCC), or coking units. These processing units create olefin compounds (such as propene) in its by-product gas that largely makes up LPG. However, the actual propene content in LPG will depend on whether or not a refinery separates the olefins from the by-product gas for use in processes that make high-octane gasoline blending materials such as alkylates. Without such processes, a refiner has no in-house use for propene. Thus, it is generally more economical for a refiner to blend the propene-rich by-product gas into its LPG product stream.

LPG from gas plants has almost no propene if the LPG comes only from production fields. However, some gas plants also receive by-product gas from refineries. LPG from such gas plants can contain substantial propene.

In California, about 90 percent of the total LPG production comes from oil refineries and 10 percent comes from gas plants in oil and gas fields. California imports roughly 25 percent from other states and Canada during the winter months (generally November through March) when demand is high and exports about the same amount to other states and other countries during the summer (generally April through October) when demand is slow. The LPG imported into California generally is of motor vehicle LPG quality (10 or less volume percent propene content).[24] California produces two grades of LPG, motor vehicle and commercial (greater than 10 volume percent propene content).

In Central California and Southern California mainly motor vehicle grade LPG is produced, while in Northern California two grades of LPG are produced. Most gas plants are concentrated in Central California, near oil producing sites. Thus, this LPG contains little or no propene and meets the motor vehicle specifications for LPG. Southern California refineries are configured such that the LPG produced is typically less than 10 volume percent propene content. In Northern California, the refineries, with one major exception, were not configured to maximize capture of light olefins for processing in alkylation units. As a result, one refiner produces motor vehicle grade LPG and two do not. Two other refineries are not selling LPG.

LPG storage is generally separated into three categories. The first is primary storage at refineries, gas plants, and pipeline tanks. Also used are large bulk storage facilities built from

depleted underground mines and salt domes, which are clustered mostly around Conway, Kansas; Hattiesburg, Mississippi; and Mont Belvieu, Texas. In California, primary storage exists at one bulk terminal with above ground tanks, and at refineries and gas plants. Secondary storage consists of above-ground tanks located at distribution centers, retail outlets, and satellite locations. The third type of storage is tertiary storage, consisting of tanks at point of end-use which are primarily at residences, businesses, and farms. During the summer months (generally April through October) when demand is slow, LPG marketers make a concerted effort to ensure that their tanks, secondary storage, are full and that their customers' tanks, tertiary storage, are also full to meet wintertime demand.[25]

In California, LPG is transported by trucks and railroad tank cars. Typically, LPG is transported by bulk transport trucks (maximum capacity of 10,000 gallons) and railroad tank cars (maximum capacity of 30,000 gallons per tank car) from the refineries and gas plants to the distribution centers and retail outlets. Smaller local delivery trucks (maximum capacity of 3000 gallons), commonly referred to as "bobtails," transport the LPG from these locations to the final customers. Most of these bobtails have the capability to fuel on the LPG that is contained in the cargo tank.

LPG is typically distributed in one of three ways:

1) A distributor/marketer picks up the LPG by bulk transport truck or railroad tank cars from a producer's loading rack and delivers it in bulk to its own regional storage facility, or directly to a customer's storage tank.

2) A distributor/marketer picks up the fuel from a bulk terminal (e.g. Suburban Elk Grove Terminal) or a regional storage facility and delivers it directly to its customers' sites, or stores it in its own storage tank, from which bobtails are used for subsequent deliveries.

3) End use customers bring their LPG portable containers or vehicles for filling at retail or wholesale facilities.

Most LPG is delivered to end users from the marketers' own storage tanks. Most marketers have only one tank and one dispensing system for LPG.

B. LPG Bobtail Delivery Truck Issues

A bobtail delivery truck is a LPG transport truck capable of transporting up to 3000 gallons of LPG. A bobtail is used to make local deliveries from the LPG distribution centers and retail outlets directly to the final customers of both non-motor vehicle and motor vehicle accounts.

Most bobtails fuel on the LPG that is contained in the cargo tank. Therefore, if the cargo fuel is for a commercial account, bobtails operating in Northern California could be running on off-specifications LPG. Although some bobtails are equipped with a side-saddle fueling tank which is independent of the cargo tank, it is neither practical nor economical for the operator to secure motor vehicle LPG, especially in areas where non-motor vehicle accounts exist.

The WPGA reported less than 1000 bobtails operating in the State with about 500 operating in Northern California. According to the suppliers and marketers of commercial propane, bobtail

trucks have routinely fueled on commercial LPG for the last ten years. Some increased maintenance and services are typical of these trucks; however, there have been no reports of any durability or engine performance problems in bobtail trucks over this time frame.[8]

C. Summary of Emissions, Performance, and Durability Testing

Studies have been conducted to evaluate emissions, engine performance, and engine durability associated with different formulations of LPG. Three emissions studies include the LPG Task Group test program, the WPGA test program, and the ARCO tests. The LPG Task Group test program is the 1998 test program coordinated by staff with a LPG Task Group established by the ARB to oversee the project. The task group consisted of representatives from refiners, engine makers, automakers, LPG marketers, and government agencies. The LPG Task Group test program also evaluated engine performance and engine durability. Detroit Diesel Company also conducted engine performance testing. Appendix C provides a detail discussion of the emissions, performance, and durability studies.

To estimate the emissions effects of bobtails operating on commercial grade LPG, staff used the LPG Task Group emissions data, which evaluated heavy-duty engine on varying propene content as high as 21 percent. Table VIII-1 summarizes the potential effects of two LPG blends with propene content greater than 10 volume percent in relation to a 10 volume percent propene LPG fuel on a Cummins B5.9 medium heavy-duty LPG engine.

Table VIII-1: Estimates of Emission Effects in LPG Heavy Duty Vehicles[a]

Greater than 10% Propene vs. 10% Propene[b]

Fuel	*NMHC or THC*	*NOx*	*CO*
	(percent change)		
1 (14.6% propene,5.0% butane)	-5%	3%	20%
2 (21.3% propene,1.6% butane)	-11%	14%	-20%

[a]Cummins B5.9 medium heavy-duty LPG engine.

[b]LPG fuel at 9.8 volume percent propene, 5.0 volume percent butane.

As shown from the table, increasing the propene content (fuel 1) appeared to decrease hydrocarbon emissions (NMHC or THC), but increase oxides of nitrogen (NOx); and carbon monoxide (CO) emission. However, increasing the propene content and reducing the butane content to less than 2.5 percent (fuel 2), as specified in the commercial LPG standard, appeared to only increase NOx emissions. As seen from the table, the NOx emission increases could be as high as 14 percent more than a 10 volume percent propene LPG fuel.

The LPG Task Group test program also evaluated engine performance and engine durability associated with different formulations of LPG on a Cummins B5.9-195 LPG engine. Detroit Diesel Company reported results on engine performance testing of a Detroit Diesel Series 50 engine. Both the Task Group and the Detroit Diesel studies reported testing only different LPG formulations up to 10 volume percent propene. The Task Group results show that for up to 10 volume percent propene content engine performance was unaffected by LPG blends, and no abnormal wear to the engine was detected. The Detroit Diesel results show that performance is well within the design of the vehicle.

IX. Environmental Impacts of the Proposed Amendments

This section discusses the environmental impact of the proposed amendments to the CNG motor vehicle fuel specifications and the LPG motor vehicle fuel specifications.

A. Overview of Environmental Impact Analysis

The staff evaluated the environmental impacts of the proposed amendments and determined that the amendments would have no significant adverse impact on public health or the environment. As discussed in Chapter IV, the proposed amendments for CNG provide an alternative set of specifications in addition to the existing CNG specifications. The proposed amendments for LPG do not change the current LPG fuel specifications but provide an exemption for specific delivery vehicles from the fuel specifications.

The staff evaluated the environmental impacts of the proposed amendments following the requirements of the California Environmental Quality Act and the Public Resources Code section 21159. The staff also followed the requirements of Health and Safety Code 43830.8, which requires the state board to conduct a multi-media evaluation before adopting any regulation that establishes a specification for motor vehicle fuels. The following discusses the specific requirements of these statutes and staff's environmental impact analysis.

B. Environmental Requirements

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential adverse environmental impacts of the proposed standards. Because the ARB's program involving the adoption of regulations has been approved by the Secretary of Resources (see Public Resources Code, section 21080.5), the CEQA environmental analysis requirements are to be included in the ARB's Staff Report in lieu of preparing an environmental impact report or negative declaration. In addition, the ARB responds in writing to all significant environmental issues raised by the public during the public review period or the public Board hearing. These responses are to be contained within the Final Statement of Reasons for the proposed amendments.

Public Resources Code section 21159 requires that the environmental impact analysis conducted by the ARB include the following: 1) an analysis of the reasonably forseeable environmental impacts of the methods of compliance, 2) an analysis of reasonably forseeable mitigation measures, and 3) an analysis of reasonably foreseeable alternative means of compliance with the standard. Our analyses of the reasonably foreseeable environmental impacts of the methods of compliance are contained in the environmental impact analysis. Because the proposed amendments do not result in any significant environmental impact, mitigation measures are not necessary. In regards to reasonably foreseeable alternative means of compliance, the proposed amendments add alternative fuel specifications; therefore, the existing fuel specifications can still be used for compliance.

Health and Safety Code section 43830.8 requires the state board to conduct a multimedia evaluation before adopting any regulation that establishes a specification for motor vehicle fuel. Section 43830.8 defines "multimedia evaluation" as "the identification and evaluation of any

significant adverse impact on public health or the environment, including air, water, or soil, that may result from the production, use, or disposal of the motor vehicle fuel that may be used to meet the state board's motor vehicle fuel specifications." Section 43830.8 also requires the California Environmental Policy Council (CEPC) to review the multimedia evaluation and determine if any significant adverse impact on public health or the environment may result from a proposed regulation. Section 43830.8 also allows the CEPC to determine, through an initial evaluation, that no multimedia evaluation is required based on its finding that a proposed regulation has no significant adverse impact on public health and the environment.

Because staff has determined that the proposed amendments will not have any significant adverse impact on public health or the environment, staff has made a formal request to the CEPC to exempt this regulatory proposal from CEPC review and the need for a multimedia evaluation. The exemption request is currently under review by the CEPC.

Below presents staff's impact analysis of the potential environmental impacts of the proposed amendments.

C. Environmental Impact Analysis

1. Effects on Water Quality and Waste Disposal

The proposed amendments to the CNG and LPG specifications do not change the existing specifications but add alternative specifications and provisions that allow increased compliance flexibility with the regulations. For CNG, to comply with the proposed specifications, producers would use the same production processes and the same waste treatment processes as are presently used to comply with the existing regulation. As discussed below, changes in fuel constituents are shifted between CNG and other fuel products already being produced. Thus, additional waste products are not expected to be generated. For LPG, the production, use, and disposal activities have not changed because staff is not proposing any amendment to the LPG specifications. Thus, the proposed amendments are not expected to result in any adverse impact to water quality or waste disposal.

2. Effects on Air Quality

Stationary Sources: For CNG, the MN index will increase the flexibility for gas producers and marketers to comply with the regulations by allowing more variability in the motor vehicle fuel formulations. This could be accomplished through operational changes of existing gas processing methods. These operational changes (e.g., additional extraction) would result in a potential increase in emissions due to additional gas processing. However, these emissions would occur regardless of the proposed amendments since industry must take action to comply with the existing regulations.

One benefit from additional gas processing would be a reduction in the reactivity of the treated natural gas. This would result in lowering the reactivity of gas transmission fugitive emissions and from downstream combustion source emissions by about 20 percent. Staff estimates that about 0.22 tons per day of gas transmission fugitive emissions in the SJV and the SCC would see a reduction in reactivity.[26] The extracted products (e.g. butanes and propanes) would be diverted

to supplement LPG production. Thus, the proposed amendments are not expected to increase emissions from the production of the fuel.

Mobile Sources: For CNG, test results show that for dedicated light-duty NGVs, even large variations in fuel composition produced only slight variations, both increases and decreases, in all emissions while bifueled vehicles had only modest changes. Heavy-duty vehicle test data showed that fueling advanced generation technologies with MN 73 fuel produced no discernible impact on PM and NOx emissions when compared to measured emissions with higher CNG fuel quality (greater than MN 80). There were small increases of NMHC emissions of about 10 percent and a six percent increase in CO_2 emissions.

Although there are small increases in NMHC and CO_2 emissions, these increases are expected to be further reduced because, as discussed in Chapter VII, industry's efforts to resolve the CNG quality issue in the SSJV and the SCC will require major gas producers to produce MN 80 CNG. This would effectively make most of the natural gas produced in these regions MN 80; thus, very little MN 73 would likely be available for motor vehicle use. Therefore, no significant impact on air quality is expected.

A concern would exist if the proposed amendments to the CNG fuel specifications were not adopted. In this case, there is a potential for existing CNG fleets and planned CNG fleet proposals to revert back to diesel vehicles. As discussed, conventional diesel vehicles are much more polluting than CNG vehicles even when operating on MN 73 CNG. Thus, not adopting the proposed CNG amendments could adversely impact air quality.

For LPG, emission tests on heavy duty vehicles operating on commercial LPG shows a 14 percent increase in NOx emissions in comparison to motor vehicle grade LPG. There were no discernible changes in other emissions. The WPGA reported that there are less than 500 bobtails operating in Northern California, consuming about two million gallons per year (MM gal/yr) of LPG. Assuming that bobtails fuel on commercial LPG about 70 percent of the time, staff estimates that the potential increase in NOx emissions results in about 0.02 tons per day.[8, 27]

If the proposed amendments are not adopted, existing LPG bobtail delivery vehicles would likely revert back to diesel. Data indicate that PM emissions are significantly greater from diesel vehicles than from LPG vehicles.[28] Therefore, PM emissions may increase above current levels if the proposal amendments are not adopted.

3. Effects of the Staff's Proposal on Greenhouse Gas (GHG) Emissions

The staff's proposal is not expected to significantly increase emissions of greenhouse gases that may contribute to global warming. Global warming is based on the premise that greenhouse gases (carbon dioxide, methane, nitrous oxide, ozone, and others) absorb infrared radiation in the atmosphere, thereby increasing the overall average global temperature. Although there is a small increase in CO_2 exhaust tail-pipe emissions from CNG vehicles running on MN 73, the use of MN 73 CNG is expected to be minimal since most of the CNG produced in the SSJV and the SCC is anticipated to comply with the MN 80 CNG. Also, if the proposed amendments are not adopted, compliance with the existing CNG specifications would require more extensive gas extraction that could generate much more greenhouse gas emissions than if a small amount of

vehicles were allowed to use CNG with an MN of 73. Therefore no significant impact on greenhouse gases is expected from the proposed amendments.

4. Public Health

The proposed amendments to the CNG and LPG motor vehicle fuel specifications would cause no significant adverse impact to public health.

5. Potential Effects of Proposed Alternative Fuel Regulations on Allowable Emissions

The proposed amendments to the CNG and LPG regulations will ensure the quality of the fuel for proper engine performance and durability, thus maintaining the emissions benefits of alternative fuels and alternative fuel vehicles.

The minimal increases in emissions of about 10 percent NMHC and six percent CO_2 from a CNG vehicle running on a MN 73 fuel versus a MN 81 fuel must be considered in light of the cleanliness of CNG vehicle emissions compared to gasoline or diesel vehicle emissions. The limited availability of motor vehicle grade CNG in the SSJV and the SCC has resulted in several potential CNG fleets and fueling sites being postponed. In some cases, proponents have elected to revert back to diesel vehicles since there is no certainty in the availability of motor vehicle grade CNG in these regions. If the continued availability of complying CNG due to the proposal prompts the development and sale of new CNG vehicles in lieu of new gasoline or diesel vehicles, the net effect of the proposal could be a decrease in future emissions. If existing CNG use in vehicles were displaced by gasoline (in re-conversions to gasoline prompted by an inadequate CNG supply), current exhaust, evaporative, and gasoline marketing emissions would increase. If re-conversions consisted of diesel vehicles, exhaust emissions of particulate matter and NOx would increase.

For LPG, if the bobtails are allowed to continue operating due to the proposal this will prevent the disruption in the marketplace. In addition, the net effect of the proposal could be a decrease in future emissions from these trucks not reverting back to diesel vehicles. If existing LPG use in bobtails would be displaced by diesel (in re-conversions to diesel prompted by an inadequate LPG supply), exhaust emissions of particulate matter would increase.

X. Economic Impacts of the Proposed Amendments to the Alternative Fuels Regulation

This chapter discusses the economic impacts that would be expected from the implementation of the proposed amendments to the CNG and LPG motor vehicle fuel specifications.

A. Overview of Economic Impact Analysis

As discussed in Chapter IV, the proposed amendments for CNG provide an alternative set of specifications in addition to the existing CNG specifications which adds flexibility and provide more cost-effective compliance options. The proposed amendments for LPG do not change the current LPG fuel specifications but provide an exemption from the fuel specifications for specific delivery vehicles thus making it more economical for LPG suppliers and distributors to market and sell their fuel.

The staff evaluated the economic impacts of the proposed amendments following the requirements of Section 11346.3 of the Government Code. Staff assessed the potential for adverse economic impacts on California business enterprises and individuals, including a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with businesses in other states. The following sections discuss the specific requirements of these statutes and staff's economic impact analysis.

B. Summary of Findings

The staff does not believe that adoption of the proposed amendments would result in significant adverse economic impacts. Consumers, producers, and marketers of vehicular CNG fuel would benefit from the proposed amendments to the CNG motor vehicle fuel specifications. Marketers of LPG fuel would benefit from the proposed amendments to the LPG motor vehicle fuel specifications. The proposed amendments would not significantly alter the profitability of most businesses though it could allow new fueling stations to be brought on-line, thus creating additional jobs. Staff also found no significant adverse fiscal impacts on any local or State agencies.

1. CNG Specifications

The proposed amendments to the CNG motor vehicle fuel specifications would not increase the cost of producing or delivering the fuel and would greatly increase the amount and availability of fuel in the SSJV and SCC that would comply with the specifications. Establishing a methane number of 80 for all natural gas vehicles in general allows compliance of approximately 20 percent of the fuel produced in the SSJV, compared to less than 1 percent compliance with the current specifications. Approximately 20 percent of the fuel produced in the SCC will comply with the methane number 80 specification compared to 11 percent compliance with the current specifications. Establishing an alternative 73 methane number for advanced generation heavy-duty engines and light duty vehicles increases the percentage complying fuel to 99 percent in the SSJV and 88 percent in the SCC and significantly increases the opportunity for siting new light-duty and heavy-duty fleets.[9] In the Los Angeles Basin, all CNG fueling facilities are supplied by

imported natural gas that meets the current CNG motor vehicle fuel specifications. Non-complying local gas production in the Los Angeles Basin is used for commercial applications and does not supply CNG fueling facilities.

The proposed amendments would allow producers, distributors and marketers to supply and sell locally produced gas that meets a minimum MN 73 in the SSJV and the SCC without further treatment or blending to CNG fleets with engine technology that can properly operate on this fuel. Engine technology that can properly operate on MN 73 CNG is based solely on the recommendation of the engine manufacturer. Costs related to verifying compliance with the amended specifications are the same as costs to verify compliance with the current specifications.

2. LPG Bobtail Exemption

The proposed amendments to the LPG motor vehicle fuel specifications would not increase the cost of producing or delivering the fuel. These proposed amendments would provide an exemption to allow LPG suppliers and distributors to deliver commercial and motor vehicle grade LPG in the same delivery trucks thus making it more economical to supply fuel to their customers. There are no costs associated with verifying compliance to the proposed exemption.

C. Economic Impacts Analysis on California Businesses as Required by the California Administrative Procedure Act (APA)

1. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with businesses in other states.

2. Findings

Staff's findings show that adoption of the proposed regulatory action would not result in significant adverse impacts on small businesses. The proposed amendments provide more flexibility to the motor vehicle fuel specifications and allow more cost effective options to comply with the regulations. The increased flexibility of the fuel specifications could allow new fueling stations to be sited, thus creating additional jobs.

D. Analysis of Potential Impacts to California State or Local State Agencies

1. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to estimate the costs or savings to any State or local agency and school district in accordance with instructions adopted by the

Department of Finance. The estimate shall include any nondiscretionary costs or savings to local agencies and the costs or savings in federal funding to the State.

2. Findings

Staff has determined that the proposed amendments would not create costs or savings, as defined in Government Code section 11346.5 (a)(6), to any State agency or in federal funding to the State, costs or mandate to any local agency or school district whether or not reimbursable by the State pursuant to Part 7 (commencing with section 17500. Division 4, Title 2 of the Government Code), or other nondiscretionary savings to local agencies. Costs related to verifying compliance with the amended specifications are the same as costs to verify compliance with the current specifications.

E. Analysis of the Cost-Effectiveness and the Impacts on a Cost per Gallon

The proposed amendments provide flexibility and provide more cost-effective compliance options. Consequently, staff believes that there will be no adverse impact on fuel cost. The alternative considered was to leave the current regulations unchanged. The compliance costs associated with the current regulations are higher than those projected with the proposed amendments.

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